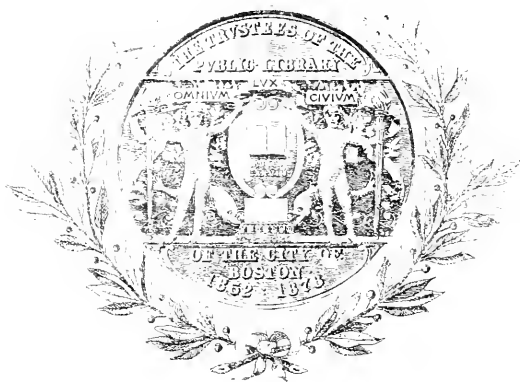
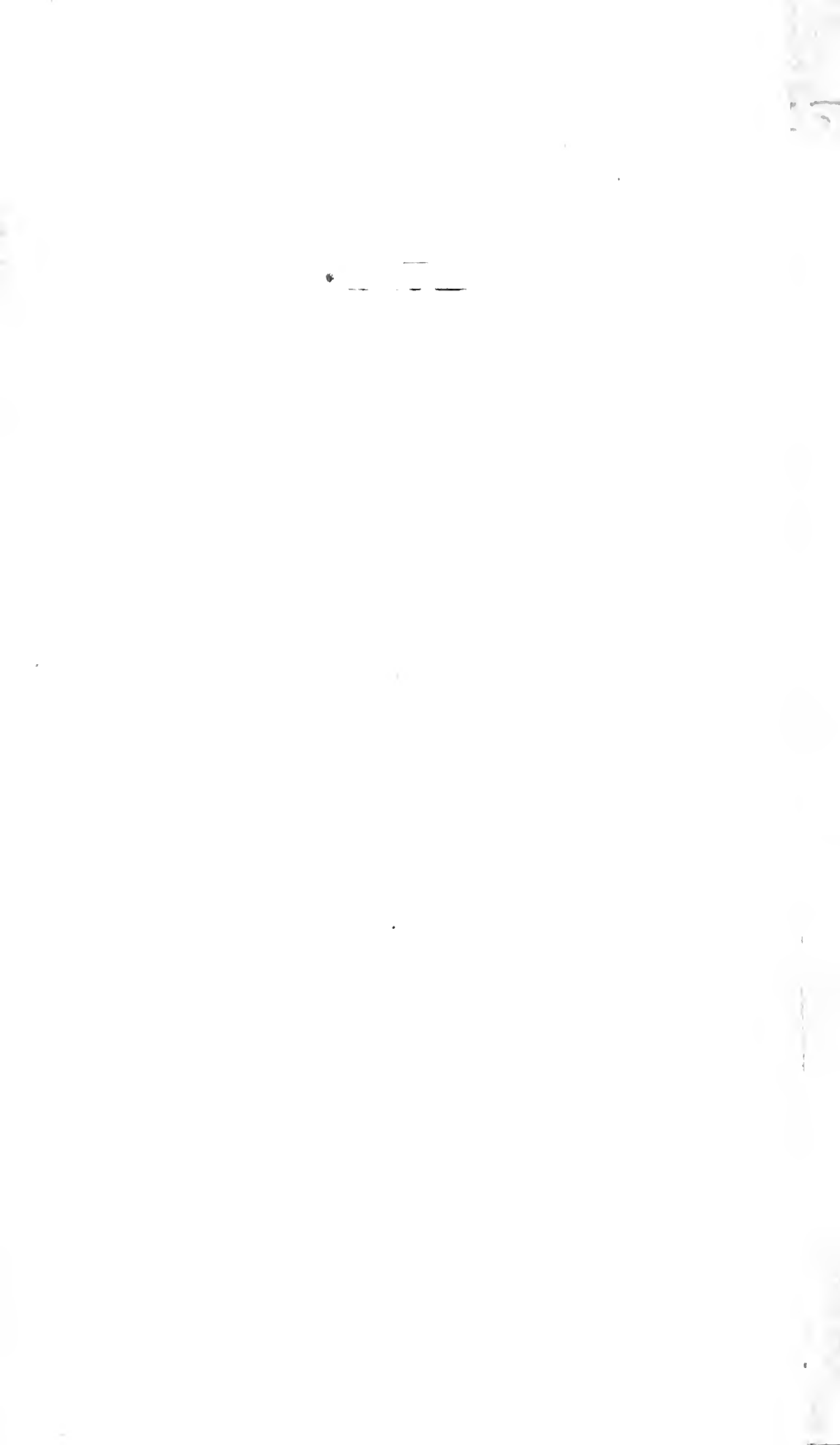


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X
BOARD OF EDUCATION.

Educational Pamphlets, No. 32.

THE ADMIRALTY METHOD
OF TRAINING DOCKYARD
APPRENTICES.

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PREFATORY NOTE.

The following paper, which describes the Admiralty method of training Dockyard Apprentices, has been prepared for the Board of Education by H.M.I. Mr. Baxandall. The Board realise that, among the problems which are at the present time engaging the attention of employers, education authorities, and teachers, few can compare in importance and extent with those relating to the proper training of industrial workers and to the provision of suitable means for the development and advancement of workmen of special ability. These objects have been attained with conspicuous success by the Admiralty Scheme, which the Board's Inspectors have found to be too little known in the country. The Board are, therefore, glad to be able, with the consent of the Admiralty, to issue this descriptive account of the system. In particular they desire to acknowledge their special indebtedness to Sir Alfred Ewing, K.C.B., the Director of Naval Education, for his assistance in connection with the preparation of this pamphlet.

Office of Special Inquiries and Reports.

August, 1916.

THE ADMIRALTY METHOD OF TRAINING DOCKYARD APPRENTICES.

I. INTRODUCTION.

The object of this report is to give a short account of a scheme for the scientific training of apprentices which is notable for the remarkable results which it has achieved and for the long period—nearly three-quarters of a century—during which it has been in operation.

Through the agency of Professional Societies, the Association of Technical Institutions, Local Education Authorities, the technical press, and individual authors, much information relating to the training of apprentices has been collected and disseminated during the last ten or fifteen years, and the merits and demerits of the various schemes instituted by many individual firms, or associations of employers, and carried out in certain university institutions, technical schools and private works have frequently come under discussion. While no doubt admitting of a simple explanation, it seems nevertheless remarkable that during such inquiry and discussion on rare occasions only has reference been made to the long-established Admiralty scheme for the training of dockyard apprentices. When discussing schemes with employers of labour, Local Education Authorities, and other persons interested in technical training, Inspectors of the Board of Education have frequently been impressed with the fact that outside the dockyard towns comparatively little is known of the scheme. These considerations have suggested that a somewhat detailed account of the scheme may be of interest at the present time.

II. THE AIM OF THE SCHEME.

The Dockyard Schools were founded by the Admiralty in 1843,* at a time when little, if any, technical instruction was provided in the dockyard towns. At the present time there exist six such schools at Chatham, Sheerness, Portsmouth, Devonport, Pembroke, and at Haulbowline in Ireland, and a school is about to be established at Rosyth.

* There was a "School of Naval Architecture" at Portsmouth from 1811 to 1832. The number of students was not to exceed 24. "The degree of merit in their examination" was to be "the only preference for admission." The examination was to be open "for all candidates who appear." Successful candidates had to sign indentures for an apprenticeship of seven years. The entrance examination consisted of Euclid, the whole of Common Arithmetic, Algebra to Quadratic Equations, English Grammar and Dictation, Reading and Translating French. Apprentices were lodged, boarded, and educated free, and were paid salaries of from £25 to £60 in lieu of clothing, &c. At the expiration of the apprenticeship they were to be "eligible to all situations in the Shipbuilding Department of His Majesty's Service, provided the apprentice shall at the expiration of the time above mentioned have completed the plan of education, and shall be certified by the Professor to be properly qualified." There was provision for apprentices entering into a bond against their leaving the Service within ten years.

One of the prime objects of the dockyard schools is the provision of qualified men for employment as draughtsmen and subordinate dockyard officers, but the Admiralty have kept in view also the possibility of obtaining through this scheme a body of men from which could be recruited the designers of ships for the Royal Navy, while at the same time increasing the efficiency of the dockyard workmen as a whole.

The schools started in a modest way by giving the most elementary form of education, the recipients attending each afternoon for three hours. Gradually the character and standard of the instruction improved, the rate of improvement increasing with the rise in the general level of the work done in public elementary schools. The curriculum was gradually extended by the inclusion of such subjects as Mathematics, the Elements of Natural Philosophy, Applied Mathematics, Mechanical Drawing, Physics, Chemistry, Applied Mechanics, Heat Engines, Metallurgy, Naval Architecture, and Electrical Engineering. In 1905 a distinct advance was made by the provision of facilities for experimental work in Science, which necessitated improvements in accommodation, equipment, and staff. In that year the whole scheme of instruction was re-drafted with a view to making it much more practical in character. At the present time all the subjects which are recognised as essential constituents of a full-time engineering course are to be found in the curricula of the Dockyard Schools, and although the standard in some subjects may not reach what is possible in full-time engineering schools, the grounding in those subjects which is given to the apprentices during their attendance of 12 hours a week at the dockyard schools is so thorough that they are able to take the fullest advantage of subsequent opportunities of attending full-time courses.

III. THE CHIEF CHARACTERISTICS OF THE SCHEME.

(i) *Admission by open competition.* Boys become apprentices in the dockyard as a result of a competitive examination held annually in London and Edinburgh and in each dockyard town, particulars of which examination are given in Section IV. of this report. The apprenticeship covers a period of six years, the different trades being shipwrights, engine fitters, electric fitters, ship fitters, patternmakers, boilermakers, caulkers, coppersmiths, joiners, founders, plumbers, painters, ropemakers, sailmakers, and smiths. Each successful candidate at the Entrance Examination is allowed to choose from the trades in which there remain vacancies after each boy above him has made his choice.

(ii) *Compulsory attendance at the Dockyard School.* Successful candidates on admission to the dockyard as apprentices are compelled to attend the dockyard school during their first year, where they receive free tuition. In one sense, the term "compulsion" is perhaps unfortunate, as attendance at school is regarded by the apprentices as a great privilege, and idleness or indifference brings summary dismissal from school.

Apprentices are classified into two sections according to their position on the list of successful candidates. The better section attend what is called the Upper School on two afternoons and three evenings each week, while the weaker section attend the Lower School on one afternoon and two evenings. Further details of the arrangements for the instruction are given in Section V.

(iii) *Annual rejection from the School.* At the end of the first year an examination is held, on the results of which some apprentices are promoted to the second year course (*i.e.*, in the Upper School), while others are either transferred to the Lower School, or they are no longer allowed the privilege of attending school. At the end of the second and third years this process of promotion and weeding out is repeated in the Upper School, and also in the Lower School at the end of the second year. As a rule, a few are promoted from the Lower to the Upper School each year. Approximately one-half of the pupils in each year are selected for promotion to the next year of the course, but circumstances may require that this proportion be exceeded or reduced in any year.

This annual weeding-out process is an important part of the scheme, and gives rise to the keenest competition; it may safely be assumed that those apprentices in the Upper School who survive it represent material of first-rate ability. Those who are rejected from the school have to rely on the local technical school for further instruction.

(iv) *Prizes.* Text-books are lent to the apprentices. Those apprentices who complete the course in either the Upper or Lower School, and earn good marks in the final examination, are allowed to retain their text-books. This reward is of considerable value, and is given with the object of encouraging apprentices to continue their studies after their school course is over.

The Admiralty give a prize to the best student in each year of the course in the Upper School. The competition for these prizes, like that for the Admiralty scholarships referred to below, is between all schools, and not in the schools individually. There is thus competition between schools as well as between apprentices in the same school.

(v) *Practical Training.*—An account of the practical training which apprentices undergo does not fall within the scope of this report, but it may be well to state that apprentices are afforded a good opportunity of acquiring a varied experience of the practical work bearing on their trade, together with experience in the drawing office. When at work in the Yard each apprentice is placed under the charge of a workman of good character. Their complete training is thus an example of the "sandwich" system in which the theoretical and practical parts alternate with a frequency approaching the practicable maximum. This arrangement, combined with the fact that the school is conducted within the works, makes it possible to secure a close connection between the two parts of the training.

(vi) *The prospects open to apprentices.* The number of apprentices entering annually is adjusted roughly to the annual loss through death, promotion, superannuation, or other causes, and hence it rarely happens that an apprentice is discharged on the completion of his apprenticeship. On account of the security of employment thus offered, the fair wages, free education, and chance of promotion, it is not surprising that the competition for admission to the dockyards is so keen.

Shipwright apprentices who complete the four years' course in the Upper School, and obtain specially good results in the school examination at the end of this period, are recommended for Cadetships in Naval Construction, and, if appointed, they will be given a year's course of combined theoretical and practical instruction at one of the large Home Dockyards before proceeding to the Royal Naval College at Greenwich for a further course of study extending over two or three years. On completing the latter course, those who obtain first or second class certificates on their final examination are confirmed in the Corps of Naval Constructors as Assistant Constructors, Second Class. Those who obtain third class certificates are eligible to receive appointments as supernumerary draughtsmen in the dockyards. Electrical fitters in like manner compete for an Admiralty scholarship in electrical engineering, the successful candidate proceeding to the Royal Naval College for a further course, at the end of which he may be selected for the post of Assistant Electrical Engineer in a dockyard. There are no corresponding Admiralty scholarships for engine fitter apprentices. But engine fitter apprentices and those of other trades, up to five each year, who show most promise at the end of their second year, are allowed to transfer to the Constructive Branch, and in that way become eligible for Construction Cadetships.

Apprentices who fail to win Admiralty scholarships usually compete for Royal Scholarships and Whitworth Exhibitions and Scholarships which are awarded on the results of examinations held by the Board of Education, and in recent years they have been remarkably successful in securing these awards. The successful candidates for such scholarships obtain leave from the Admiralty to continue their education at approved institutions such as the Imperial College of Science and Technology, or other institutions of university rank, where, in virtue of their previous training, they frequently are allowed to omit a considerable part of the three or four years' course and devote part of their time to post graduate and research work. They afterwards return to the dockyards, or find posts in other Government departments or private firms; a few of them enter the teaching profession. But of course the large majority of apprentices remain in the dockyard service, and, on completing their apprenticeship, have opportunities of competing for positions such as those of draughtsman, and inspector.

IV. THE ENTRANCE EXAMINATION.

The examination is open to all lads of British nationality who are between 15 and 16 years of age and are of sound constitution. In practice, however, it is confined to boys whose parents or guardians reside within reach of the dockyard, as the boys, if successful, must live near their work. It is conducted by the Civil Service Commissioners, and is held in London and Edinburgh and the dockyard towns in April of each year. The subjects of examination are :—English (Composition, Literature, and Handwriting), History and Geography, Arithmetic, Algebra and Geometry, Drawing, and Elementary Science. In Science there is no examination in practical work. The examination in Drawing consists of a freehand sketch of a simple object with which each candidate is supplied. There is no oral examination.

Preparation for this examination takes place in many types of schools, including public elementary, higher elementary, junior technical, and secondary schools. In the dockyard towns there are also private day schools and evening classes at which boys are specially coached for the examination.

This examination serves also for the entry of Boy Artificers and Boy Shipwrights into the Royal Navy, though a number of Boy Artificers are also entered by another examination in which competition is limited to candidates recommended by various Education Authorities throughout the country.

V. THE ORGANISATION AND CURRICULUM OF THE DOCKYARD SCHOOLS.

The schools are open during about 40 weeks in each year. Apprentices who are selected for the Upper School attend on each of two afternoons a week from 1.30 to 4.30, returning in the evenings for further instruction from 6.0 to 8.0; on a third evening they attend for a like period, for which purpose they are allowed to cease work in the Yard at 4.30. They thus receive instruction for 6 hours a week during ordinary working hours, and for 6 hours outside ordinary working hours, or 12 hours a week in all. The complete course extends over 4 years. Those selected for the Lower School attend on one afternoon a week for 3 hours and on two evenings for 2 hours, making a total of 7 hours a week. The complete course in the Lower School extends over 3 years.

At each dockyard the two schools are conducted by one headmaster. He has the services of one or more full-time assistants, and in the evenings he receives assistance from one or more specially qualified men engaged during the day in the Yard.

The buildings were not erected for teaching purposes, but they have been adapted to meet school requirements. In one or two cases extensions have recently been made to provide laboratories and additional classroom accommodation. A very considerable amount of equipment for teaching science has been provided during the last ten years.

In the Upper School the "School Course" is practically the same for apprentices in all trades throughout the course, but it is supplemented in the third and fourth years by "Professional Lectures" for apprentices in special trades. In the Lower School there are no professional lectures, but with this exception the curriculum is on much the same lines as that of the Upper School, though the work is of a more elementary character.

The curriculum of the Upper School is set out in the following table :—

First Year.	Second Year.
<i>For apprentices of all trades.</i> English. Practical Mathematics. Elementary Science. Mechanics.	<i>For apprentices of all trades.</i> English. Practical Mathematics. Mechanics. Heat and Metallurgy. Mechanical Drawing.
Third Year.	Fourth Year.
<i>For apprentices of all trades.</i> Practical Mathematics. Applied Mechanics. Electricity. Mechanical Drawing.	<i>For apprentices of all trades.</i> Practical Mathematics. Applied Mechanics. Electricity. Mechanical Drawing. Heat and Metallurgy.
<i>Professional Subjects :—</i>	<i>Professional Subjects.</i>
<i>For engine fitter apprentices and those of kindred trades and electrical fitters.</i> Steam and Heat Engines.	<i>For engine fitter apprentices and those of kindred trades.</i> Steam and Heat Engines. General Engineering.
<i>For engine fitter apprentices, and those of kindred trades.</i> General Engineering.	<i>For electrical fitter apprentices only.</i> Electrical Engineering.
<i>For shipwright apprentices and those of kindred trades.</i> Naval Architecture.	<i>For shipwright apprentices and those of kindred trades.</i> Naval Architecture.

The aim of the work in English is to cultivate the power of clearly expressing ideas in writing. Lectures on subjects of general interest and educational value are given, and are followed by the writing of essays on these and other subjects. A special period in History is studied and dealt with on the lines of Green's Short History of the English People, the growth of the nation, its constitutional, social, and intellectual advance being considered. The literature of the period is studied, and passages read and explained to the boys.

The mathematical work of the first two years is much on the lines usually followed in a course of Practical Mathematics, an all-round knowledge of the subject being given. By the end of

the second year considerable progress has been made with the differential and integral calculus. Each branch of the subject is developed in the third and fourth years, co-ordinate geometry of two dimensions and also of three dimensions being studied, while the fourth year work in calculus includes double and triple integration and differential equations, with applications to physics and engineering. From one-third to one-half of the total time is devoted to the subject in the first two years. The standard attained is exceptionally high, and is probably not exceeded in any existing educational institution, if regard is had to the age of the boys and the schools from which they are drawn, and to the fact that they are receiving a part-time training. There can be little doubt that the excellent mathematical training which the apprentices receive in the dockyard schools accounts for the rapid progress which they are able to make in the study of other engineering subjects, and for their confidence and power in attacking problems.

The Science work in the first year consists of physical measurements, heat, light, magnetism and electricity, mechanics, and chemistry. Mechanics is continued for the rest of the course, and is taken by apprentices in all trades. It includes what is commonly understood by "theoretical mechanics," as well as applied mechanics, the latter including theory of machines, strength of materials and hydraulics. The lectures in metallurgy given in the second and fourth years deal chiefly with the physical properties of metals used in engineering and shipbuilding; the manufacture of cast iron and wrought iron, and the various processes of steel manufacture; the mechanical and heat treatment of steel; and the effects on the physical properties of steel of small quantities of such metals as manganese, nickel, chromium, and tungsten. Under the heading of Steam and Heat Engines the theory of the subject mainly is dealt with, while in general Engineering the work is mainly descriptive in character and deals with the practical side of the subject, the construction and action of the propelling machinery, boilers, and other machinery on board ship, and such matters as the use of oil fuel, being considered.

Instruction in technical electricity is given to apprentices in all trades during the third and fourth years, and in the case of electrical fitters this develops into electrical engineering in the fourth year.

Mechanical Drawing is not taught in the first year, but the course in mathematics in that year includes some practical geometry. In the second and third years the elements of machine drawing and ship drawing, including descriptive geometry, are taught. All apprentices who reach the fourth year are given such instruction for that year in the drawing offices of their respective departments as will enable them to execute drawings connected with their respective trades made to scale from measurements taken by themselves, and during this time are allowed time to produce a trial drawing which they must submit for examination at the end of the session.

VI. GENERAL REMARKS ON THE SCHEME.

This scheme is entirely British in origin, and its character is in keeping with the present democratic age. Its outstanding feature is the clear field which it gives to ability. Entry of apprentices is by competition without nomination. Retention in school from year to year is the result of an examination held annually by the Admiralty, and the Cadetships in Naval Construction are awarded solely on the results of this examination at the end of the fourth year. A boy entering from any class may secure advancement to the highest positions solely as the result of his own ability and hard work. It has supplied to the nation a large proportion of distinguished naval architects and engineers, who, through service with the Admiralty and private firms have contributed to the pre-eminence in shipbuilding which this country holds at the present day. Among these are several who have occupied the position of Director of Naval Construction at the Admiralty.

The following is a list of some distinguished Dockyard Apprentices :—

Sir Nathaniel Barnaby, K.C.B. ...	Director of Naval Construction.
Sir F. H. Biles, LL.D., D.Sc. ...	Professor of Naval Architecture, Glasgow University.
Sir A. J. Durston, K.C.B. ...	Engineer-in-Chief.
Frank Elgar, Esq., LL.D., F.R.S.	Director of Dockyards, Admiralty.
Rear-Admiral Goodwin ...	Deputy Engineer-in-Chief, Admiralty.
P. Jenkins, Esq. ...	Professor of Naval Architecture, Glasgow University.
Sir J. B. Marshall, K.C.B. ...	Director of Dockyards.
Sir Thomas Mitchell, M.V.O. ...	Manager, Constructive Department, Portsmouth.
Sir H. J. Oram, K.C.B., F.R.S....	Engineer-in-Chief of the Fleet.
Sir William Pearce, Bart. ...	Managing Director, Fairfield Works.
Sir Edward Reed ...	Director of Naval Construction.
Sir William Smith, C.B. ...	Superintendent of Contract Work, Admiralty.
S. J. P. Thearle, Esq., D.Sc. ...	Chief Ship Surveyor, Lloyds.
Sir Philip Watts, K.C.B., F.R.S....	Director of Naval Construction.
J. J. Welch, Esq., M.Sc. ...	Professor of Naval Architecture, Durham University.
Sir W. H. White, K.C.B., F.R.S....	Director of Naval Construction.

During its long history the scheme has undergone many changes in detail which have been suggested by experience and a clearer realisation of the needs of the future. In these changes are reflected many of the features in the development of the instruction given in our primary, secondary, and technical schools, and the dockyard schools have undoubtedly raised the educational standard for boys in dockyard towns. The achievements of apprentices in one generation have fired the imagination of those in the next, and at a very early age boys in these towns have come under the influence of a competition to which, as regards keenness and active interest of parents, there probably exists no parallel in any other part of the country.

Having stood the test of time, and having in so large a measure achieved the objects with which it was instituted, the method can lay claim to wider publicity, especially at a time when the question of increasing the industrial efficiency of the nation is under consideration, and existing methods of training apprentices are being scrutinised.

G. A. BAXANDALL.

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